CLAIMS

What is claimed is:

1. An optical cross-connect switch for routing optical multiplexed signals in an optical transport network, comprising:

a plurality of signal splitters, each signal splitter having an input for receiving an optical multiplexed signal therein and a plurality of outputs, each signal splitter further operable to partition the optical multiplexed signal into a plurality of optical multiplexed signals;

a plurality of wavelength selective devices connected to the plurality of signal splitters, such that a wavelength selective device is disposed at each output of each signal splitter, each wavelength selective device receiving an optical multiplexed signal therein and operable at different wavelengths to manipulate optical data signals embodied in the optical multiplexed signal; and

a plurality of signal combiners connected to the plurality of wavelength selective devices, such that each signal combiner is adapted to receive an optical multiplexed signal via a wavelength selective device from each of the plurality of signal splitters, each signal combiner operable to pass the optical multiplexed signal to an outlet port of the switch.

2. The optical cross-connect switch of Claim 1 wherein the plurality of wavelength selective devices cooperatively operate to route incoming optical multiplexed signals amongst outlet ports of the cross-connect switch.

3. The optical cross-connect switch of Claim 1 wherein each of the wavelength selective device is operable to at least one of pass thru, route, or block the optical multiplexed signal received therein.

4. The optical cross-connect switch of Claim 1 wherein the plurality of wavelength selective devices are further defined as either wavelength selective blockers, wavelength selective switches or a combination thereof.

5. The optical cross-connect switch of Claim 1 wherein each signal splitter is connected to at least one wavelength selective switch, thereby providing signal add/drop capability.

6. The optical cross-connect switch of Claim 5 wherein each signal splitter is connected to at least two wavelength selective switches, thereby providing redundant signal add/drop capability.

7. The optical cross-connect switch of Claim 5 wherein the at least one wavelength selective switch having at least two inputs, a first input for receiving the optical multiplexed signal from a signal splitter and a second input for introducing an additional optical multiplexed signal into the cross-connect switch.

8. The optical cross-connect switch of Claim 5 wherein the at least one wavelength selective switch having at least two outputs, a first output connected to a signal combiner and a second output for dropping one or more optical data signals embodied in the optical multiplexed signal from the switch.

9. The optical cross-connect switch of Claim 1 wherein the plurality of wavelength selective devices are arranged in a cascading manner, thereby reducing the number of wavelength selective devices residing in the cross-connect switch.

10. The optical cross-connect switch of Claim 9 wherein a plurality of wavelength selective switches are connected to the outputs of the plurality of signal splitters and a plurality of wavelength selective blockers are interposed between the plurality of wavelength selective switches and the plurality of signal combiners, such that the number of wavelength selective switches is $\lceil (N/2) \rceil * \lceil (N/2) \rceil$, and the number of wavelength selective blockers is $N * \lceil N/2 \rceil$, where N is the number of inlet ports supported by the cross-connect switch and the ceiling function $\lceil x \rceil$ is defined as the smallest integer greater or equal than x.

11. A method for routing optical multiplexed signals in an optical cross-connect switch, the switch having a plurality of inlet ports and a plurality of outlet ports, comprising:

receiving an optical multiplexed signal at each inlet port of the cross-connect switch;

dividing each of the optical multiplexed signals into a plurality of optical multiplexed signals;

routing the plurality of optical multiplexed signals to a plurality of wavelength selective blockers, where each wavelength selective blocker receives an optical multiplexed signal therein and is operable to at least one of pass thru or block optical data signals embodied in the optical multiplexed signals;

connecting the plurality of wavelength selective blockers to the plurality of outlet ports, such that each outlet port is adapted to receive an optical multiplexed signal via a wavelength selective blocker from each of the plurality of inlet ports, with the exception of a complementary inlet port; and

selectively passing the plurality of optical multiplexed signals through the plurality of wavelength selective blockers to the plurality of outlet ports, thereby routing optical multiplexed signals in the optical cross-connect switch.

12. The method of Claim 11 further comprises using N*(N-1) wavelength selective blockers, where N is equal to the number of inlet ports.

13. The method of Claim 11 wherein the step of connecting the plurality of wavelength selective blockers to the plurality of outlet ports further comprises adapting each outlet port to receive an optical multiplexed signal from each of the plurality of inlet ports, including a complementary inlet port, thereby supporting loop-back capability.

14. The method of Claim 13 further comprises using N*N wavelength selective blockers, where N is equal to the number of inlet ports.

15. The method of Claim 11 wherein the step of dividing each of the optical multiplexed signals into a plurality of optical multiplexed signals further comprises using a plurality of signal splitters, such that a signal splitter is disposed at each of the inlet ports.

16. The method of Claim 11 wherein the step of connecting the plurality of wavelength selective blockers to the plurality of outlet ports further comprises connecting the plurality of wavelength selective blockers to a plurality of signal combiners, such that each signal combiner is

adapted to receive an optical multiplexed signal via a wavelength selective blocker from each of the plurality of inlet ports.

17. An optical cross-connect switch for routing optical multiplexed signals in an optical transport network, comprising:

a plurality of inlet ports, each inlet port receiving an optical multiplexed signal therein;

a plurality of signal splitters connected to the plurality of inlet ports, each signal splitter receiving an optical multiplexed signal from one of the plurality of inlet ports and operable to partition the optical multiplexed signal into a plurality of optical multiplexed signals;

a plurality of wavelength selective devices connected to the plurality of signal splitters, each wavelength selective device receiving an optical multiplexed signal from a signal splitter and operable to manipulate optical data signals that are transmitted at different wavelengths and embodied in the optical multiplexed signal; and

a plurality of signal combiners connected to the plurality of wavelength selective devices, such that each signal combiner is adapted to receive an optical multiplexed signal via a wavelength selective device from each of the plurality of inlet ports, with the exception of a complementary inlet port; and

a plurality of outlet ports, each outlet port receiving an optical multiplexed signal from one of the plurality of signal combiners.

18. The optical cross-connect switch of Claim 17 wherein the plurality of wavelength selective devices cooperatively operate to route incoming optical multiplexed signals amongst the plurality of outlet ports of the cross-connect switch.

19. The optical cross-connect switch of Claim 17 wherein the plurality of wavelength selective devices are further defined as either wavelength selective blockers, wavelength selective switches or a combination thereof.

20. The optical cross-connect switch of Claim 17 wherein each signal splitter includes a number of outputs that corresponds to the number of outlet ports, such that at least one of the outputs for the signal splitter is adapted to drop the optical multiplexed signal from the optical transport network.

21. The optical cross-connect switch of Claim 17 wherein each signal combiner includes a number of inputs that corresponds to the number of inlet ports, such that at least one of the inputs to the signal combiner is adapted to add an additional optical multiplexed signal into the optical transport network.

22. The optical cross-connect switch of Claim 17 wherein each signal combiner is adapted to receive an optical multiplexed signal from each of the plurality of inlet ports, including a complementary inlet port, thereby supporting loop-back capability.

23. The optical cross-connect switch of Claim 17 wherein the plurality of wavelength selective devices are arranged in a cascading manner, thereby reducing the number of wavelength selective devices residing in the cross-connect switch.

24. The optical cross-connect switch of Claim 23 wherein a plurality of wavelength selective switches are connected to the outputs of the plurality of signal splitters and a plurality of wavelength selective blockers are interposed between the plurality of wavelength selective switches and the plurality of signal combiners, such that the number of wavelength selective switches is $\lceil (N/2) \rceil * \lceil (N/2) - 1 \rceil$, and the number of wavelength selective blockers is N*(N/2) for an even number of inlet ports and ((N+1)*(N/2))-1 for odd number of inlet ports, where N is the number of inlet ports supported by the cross-connect switch and the ceiling function $\lceil x \rceil$ is defined as the smallest integer greater or equal than x.

25. An optical cross-connect switch site for routing optical multiplexed signals in an optical transport network, comprising:

a plurality of inlet ports, each inlet port receiving an optical multiplexed signal therein;

a plurality of wavelength selective switches connected to the plurality of inlet ports, each wavelength selective switch receiving an optical multiplexed signal and operable to route the optical multiplexed signal amongst a plurality of outputs, each wavelength selective switch further operable to manipulate optical data signals that are transmitted at different wavelengths and embodied in the optical multiplexed signal; and

a plurality of signal combiners connected to the plurality of wavelength selective switches, such that each signal combiner is adapted to receive an optical multiplexed signal via a wavelength selective switch from each of the plurality of inlet ports, with the exception of a complementary inlet port; and

a plurality of outlet ports, each outlet port receiving an optical multiplexed signal from one of the plurality of signal combiners.

26. The optical cross-connect switch site of Claim 25 wherein the plurality of wavelength selective switches cooperatively operate to route incoming optical multiplexed signals amongst the plurality of outlet ports of the cross-connect switch.

27. The optical cross-connect switch site of Claim 25 wherein each wavelength selective switch includes a number of outputs that corresponds to the number of outlet ports, such that at least one of the outputs is adapted to drop one or more optical data signals embodied in the optical multiplexed signal from the optical transport network.

28. The optical cross-connect switch site of Claim 25 wherein each signal combiner includes a number of inputs that corresponds to the number of inlet ports, such that at least one of the inputs for the signal combiner is adapted to add an additional optical signal into the optical transport network.

29. The optical cross-connect switch site of Claim 25 further comprising a plurality of signal splitters, such that a signal splitter is disposed between each of the inlet ports and at least two wavelength selective switches.

30. A method for routing optical multiplexed signals in an optical cross-connect switch, the cross-connect switch having a plurality of inlet ports and a plurality of outlet ports, comprising:

receiving an optical multiplexed signal at an inlet port of the cross-connect switch, the optical multiplexed signal embodying optical data signals having different transmission bit rates;

filtering the optical multiplexed signal into a first optical multiplexed signal having a first bit rate and a second optical multiplexed signal having a second bit rate;

dividing the first optical multiplexed signal into a plurality of first optical multiplexed signals;

routing the plurality of first optical multiplexed signals to a first set of wavelength selective devices, where each wavelength selective device receives one of the plurality of first optical multiplexed signals and is operable at the first bit rate to manipulate optical data signals embodied therein;

dividing the second optical multiplexed signal into a plurality of second optical multiplexed signals; and

routing the plurality of second optical multiplexed signals to a second set of wavelength selective devices, where each wavelength selective device receives one of the plurality of second optical multiplexed signal and is operable at the second bit rate to manipulate optical data signals embodied in the optical multiplexed signals.

31. An optical cross-connect switch for routing optical multiplexed signals in an optical transport network, comprising:

a plurality of inlet ports, each inlet port receiving an optical multiplexed signal therein, where the optical multiplexed signal embodies optical data signals having different transmission bit rates;

a plurality of filters connected to the plurality of inlet ports, each filter receiving an optical multiplexed signal from one of the plurality of inlet ports and operable to output a first filtered optical signal having a first bit rate and a second filtered optical signal having a second bit rate;

a first set of signal splitters connected to the plurality of filters, each signal splitter receiving a first filtered optical signal from one of the plurality of filters and operable to partition the first filtered optical signal into a plurality of first filtered optical signals;

a first set of wavelength selective devices connected to the plurality of signal splitters, each wavelength selective device receives a first filtered optical signal and operable at different wavelengths to manipulate optical data signals embodied in the first filtered optical signal;

a second set of signal splitters connected to the plurality of filters, each signal splitter receiving a second filtered optical signal from one of the plurality of filters and operable to partition the second filtered optical signal into a plurality of second filtered optical signals;

a second set of wavelength selective devices connected to the plurality of signal splitters, each wavelength selective device receives a

second filtered optical signal and operable at different wavelengths to manipulate optical data signals embodied in the second filtered optical signal; and

a plurality of signal combiners connected to the first set of wavelength selective devices and the second set of wavelength selective devices, such that each signal combiner is adapted to receive a first filtered optical signal and a second filtered optical signal from each of the plurality of inlet ports, with the exception of a complementary inlet port, and operable to combine the first filtered optical signal and the second filtered optical signal to form an outgoing optical multiplexed signal.

32. The optical cross-connect switch of Claim 31 wherein the wavelength selective devices cooperatively operate to route incoming optical multiplexed signals amongst a plurality of outlet ports of the cross-connect switch.

33. The optical cross-connect switch of Claim 31 wherein the wavelength selective devices are further defined as either wavelength selective blockers, wavelength selective switches or a combination thereof.

34. The optical cross-connect switch of Claim 31 wherein each signal splitter includes a number of outputs that corresponds to the number of outlet ports, such that at least one of the outputs for the signal splitter is adapted to drop an optical multiplexed signal from the optical transport network.

35. The optical cross-connect switch of Claim 31 wherein each signal combiner includes a number of inputs which is (N*2)-1, where N is the number of inlet ports supported by the cross-connect switch and at least one of the inputs to the signal combiner is adapted to add an additional optical multiplexed signal into the optical transport network.

36. The optical cross-connect switch of Claim 31 wherein each signal splitter is connected to at least one wavelength selective switch, thereby providing signal add/drop capability.

37. The optical cross-connect switch of Claim 36 wherein the at least one wavelength selective switch having at least two inputs, a first input for receiving the optical multiplexed signal from a signal splitter and a second input for introducing an additional optical signal into the cross-connect switch.

38. The optical cross-connect switch of Claim 36 wherein the at least one wavelength selective switch having at least two outputs, a first output connected to a signal combiner and a second output for dropping one or more optical data signals from the switch.

39. The optical cross-connect switch of Claim 31 further comprises:

a first set of signal combiners connected to the first set of wavelength selective devices, such that each signal combiner is adapted to receive a first filtered optical signal from each of the plurality of inlet ports, with the exception of a complementary inlet port;

a second set of signal combiners connected to the first set of wavelength selective devices, such that each signal combiner is adapted to receive a second filtered optical signal from each of the plurality of inlet ports, with the exception of a complementary inlet port; and

a second set of filters connected to the first and second set of signal combiners, such that each filter is adapted to receive a first filter optical signal and a second optical signal, and operable to combine the first filtered optical signal and the second filtered optical signal to form an outgoing optical multiplexed signal.

40. The optical cross-connect switch of Claim 39 further comprises a third set of signal combiners connected to the second set of filters, each signal combiner in the third set of signal combiners receiving an outgoing optical multiplexed signal from one of the second set of filters and operable to introduce an additional optical signal into the cross-connect switch, thereby providing signal add capability.

41. The optical cross-connect switch of Claim 31 further comprises a third set of signal splitters interposed between the plurality of inlet ports and the plurality of filters, each signal splitter receiving an optical multiplexed signal from one of the plurality of inlet ports and operable to partition the optical multiplexed signal into two optical multiplexed signals, thereby providing signal drop capability.

42. The optical cross-connect switch of Claim 31 further comprises a third set of signal combiners connected to the plurality of signal combiners, each signal combiner in the second set of signal combiners receiving an outgoing optical multiplexed signal from one of the plurality of signal combiners and operable to introduce an additional optical signal into the cross-connect switch, thereby providing signal add capability.

43. The optical cross-connect switch of Claim 31 further comprises:

a first set of switching devices interposed between the plurality of inlet ports and the plurality of filters, each switching device receiving an optical multiplexed signal from one of the plurality of inlet ports and operable to route the optical multiplexed signal amongst at least two outputs;

a second set of switching devices interposed between the plurality of filters and the first set of signal splitters, each switching device is adapted to receive two input signals, including a first filtered optical signal from one of the first set of signal splitters; and

a third set of switching devices interposed between the plurality of filters and the second set of signal splitters, each switching device is adapted to receive two input signals, including a second filtered optical signal from one of the second set of signal splitters.

44. The optical cross-connect switch of Claim 43 further comprises a third set of signal splitters interposed between the plurality of inlet ports and the first set of switching devices, each signal splitter receiving an optical multiplexed signal from one of the plurality of inlet ports and operable to partition the optical multiplexed signal into two optical multiplexed signals, thereby providing signal drop capability.

45. An optical cross-connect switch site for routing optical multiplexed signals in an optical transport network, comprising:

a plurality of inlet ports, each inlet port receiving an optical multiplexed signal therein, where the optical multiplexed signal embodies optical data signals having different transmission bit rates;

a plurality of signal splitters connected to the plurality of inlet ports, each signal splitter receiving an optical multiplexed signal from one of the plurality of inlet ports and operable to partition the optical multiplexed signal into a plurality of optical multiplexed signals;

a first set of switching devices connected to the plurality of signal splitters, each switching device receiving an optical multiplexed signal and operable to route the optical multiplexed signal amongst at least two outputs;

a plurality of wavelength selective devices connected to the plurality of switching devices, such that at least one wavelength selective device is connected to each switching device and operable at different bit rates to manipulate optical data signals embodied in the optical multiplexed signal;

a second set of switching devices connected to the plurality of wavelength selective devices, such that each switching device is connected to at least one wavelength selective device; and

a plurality of signal combiners connected to the second set of switching devices, such that each signal combiner is adapted to receive an optical multiplexed signal via at least one wavelength selective device

from each of the plurality of inlet ports, with the exception of a complementary inlet port, and operable to pass the optical multiplexed signal to an outlet port of the cross-connect switch.

46. The optical cross-connect switch site of Claim 45 wherein the plurality of wavelength selective devices cooperatively operate to route incoming optical multiplexed signals amongst the plurality of outlet ports of the cross-connect switch.

47. The optical cross-connect switch site of Claim 45 wherein the plurality of wavelength selective devices are further defined as either wavelength selective blockers, wavelength selective switches or a combination thereof.

48. The optical cross-connect switch site of Claim 45 wherein each signal splitter includes a number of outputs that corresponds to the number of outlet ports, such that at least one of the outputs for the signal splitter is adapted to drop the optical multiplexed signal from the optical transport network.

49. The optical cross-connect switch site of Claim 45 wherein each signal combiner includes a number of inputs that corresponds to the number of inlet ports, such that at least one of the inputs to the signal combiner is adapted to add an additional optical multiplexed signal into the optical transport network.

50. The optical cross-connect switch site of Claim 45 wherein each signal combiner is adapted to receive an optical multiplexed signal from each of the plurality of inlet ports, including a complementary inlet port, thereby supporting loop-back capability.